MJO-NAO connection and its impacts on subseasonal prediction

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March 30, 2015, NMME S2S workshop

NCWCP, College Park

Outlines

- Connection between the MJO and the NAO
- MJO influence on North American SAT
- Subseasonal prediction of the MJO and NAO

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The Madden-Julian Oscillation (MJO)

- Discovered by Madden and Julian (1971). Spectrum analysis of 10 year record of SLP at Canton, and upper level zonal wind at Singapore. Peak at 40-50 days.
- Dominant tropical wave on intraseasonal time scale
- 30-60 day period, wavenumber 1~3
- propagates eastward along the equator (~5 m/s in eastern Hemisphere, and ~10 m/s in western Hemisphere)
- Organizes convection and precipitation

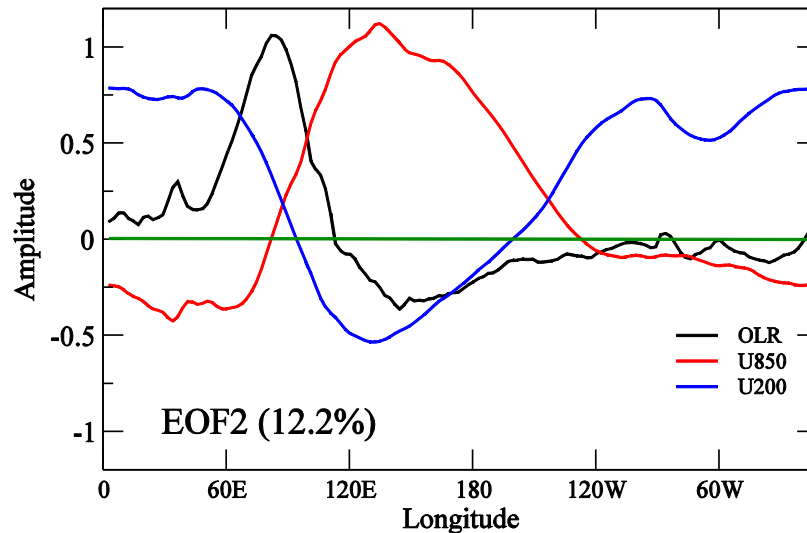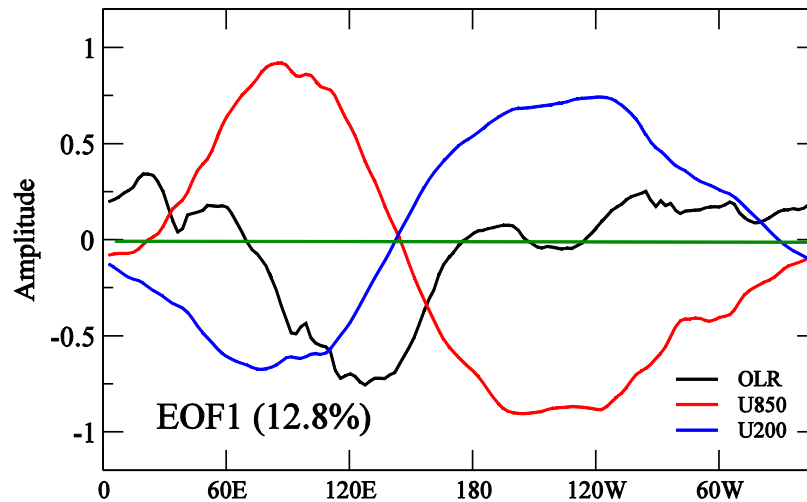Environment Canada   Environnement Canada

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MJO index

Wheeler-Hendon index

- 3-D structure: OLR, u850, u200
- Remove seasonal cycle, and interannal variability
- Band average between 15°S and 15°N
- Combined EOF analisys
- Unfiltered daily data, real time monitor and forecast application

# Longitudinal distribution of the leading two EOFs

- Wavenumber 1

- Baroclinic vertical structure

- EOF1 and EOF2 in quadrature

- PC1 and PC2 have a power spectrum peak 30-80 days, with 65% of total variance in this band

- PC1 leads PC2 by 10 days

Wheeler and Hendon (2004)

Composites of tropical

Precipitation rate for 8
MJO phases,
according to Wheeler
and Hendon index.

Xie and Arkin pentad
data, 1979-2003
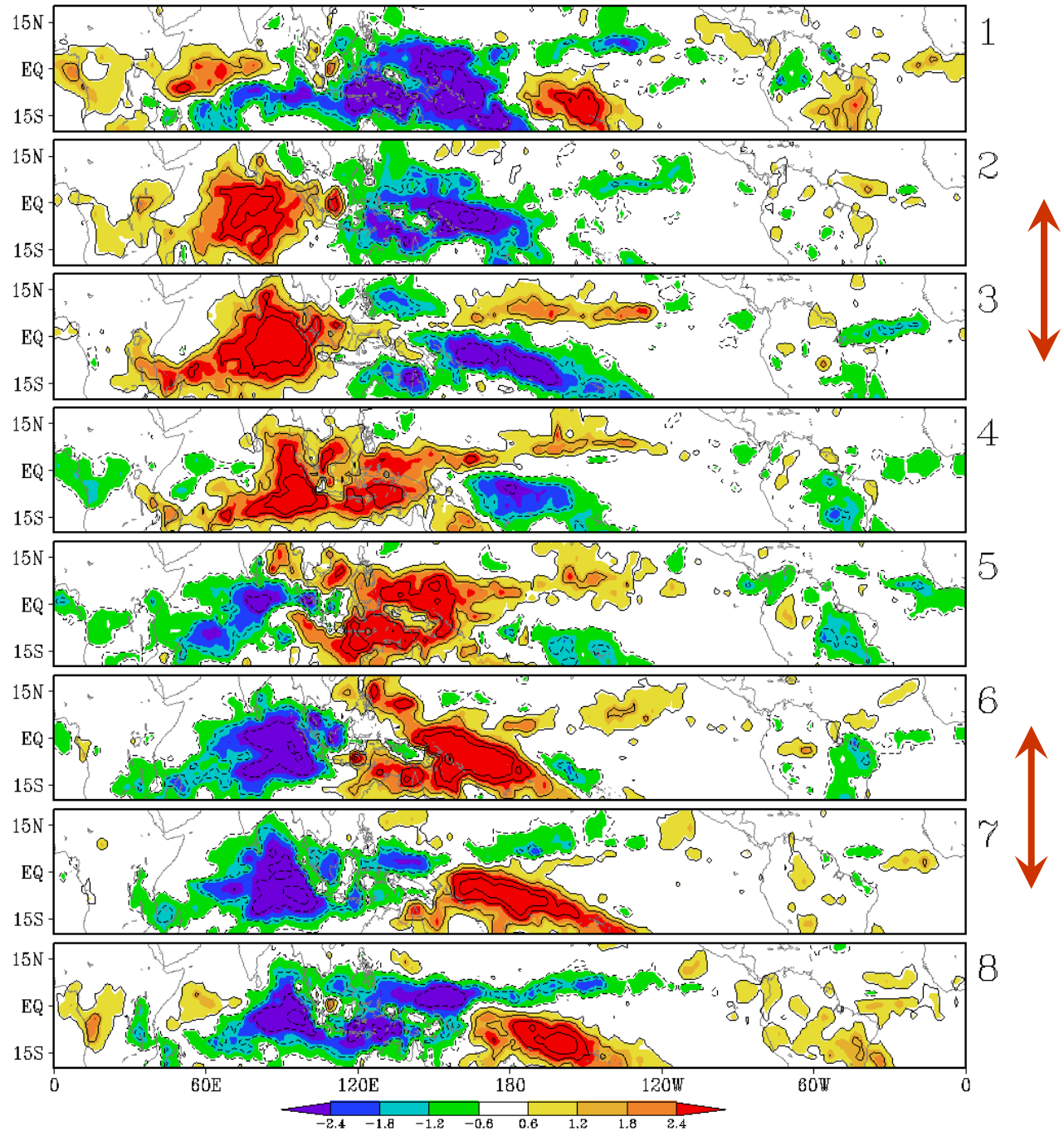
Connection between the MJO and NAO

Data

NAO index: pentad average

MJO RMMs: pentad average

Period: 1979-2003

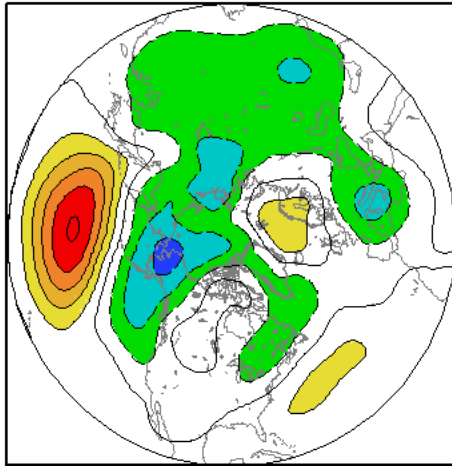Extended winter, November to April (36 pentads each winter)

Lagged probability of the NAO index
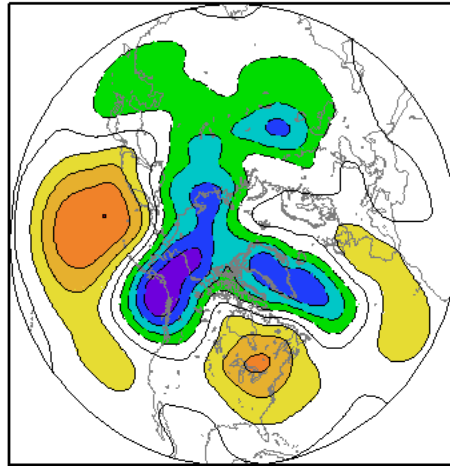**Positive: upper tercile**; Negative: low tercile

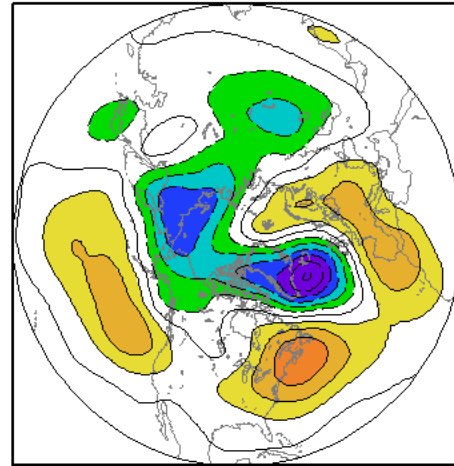| Phase	1	2	3	4	5	6	7	8
Lag −5		−35%	−40%			+49%	+49%	
Lag −4						+52%	+46%	
Lag −3		−40%					+46%	
Lag −2						+50%		
Lag −1								
Lag 0				+45%				−42%
Lag +1			+47%	+45%				−46%
Lag +2		+47%	+50%	+42%		−41%	−41%	−42%
Lag +3		+48%				−41%	−48%	
Lag +4						−39%	−48%	
Lag +5				−41%				

(Lin et al. JCLIM, 2009)
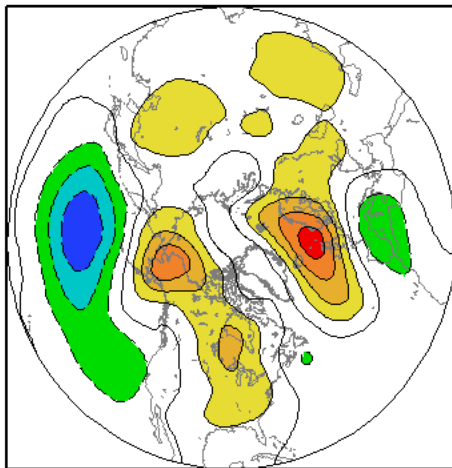
Tropical influence

a) PHASE 3 lag=0   b) PHASE 3 lag=1   c) PHASE 3 lag=2
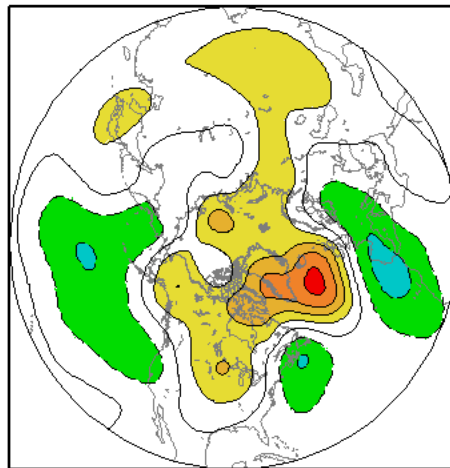
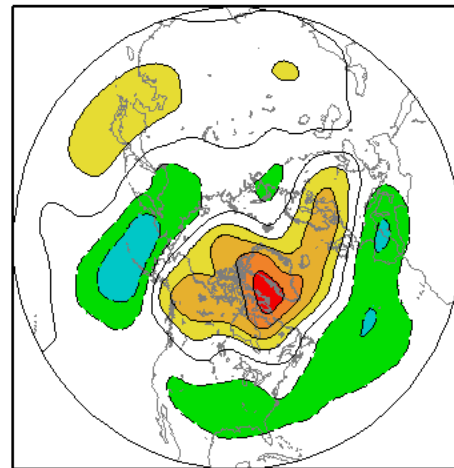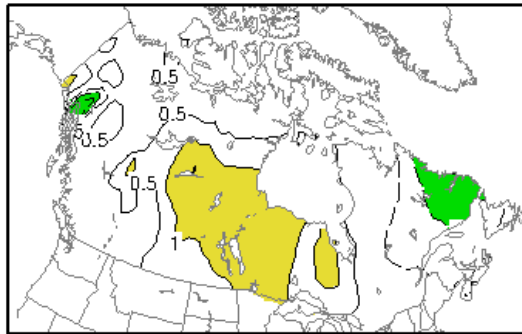d) PHASE 7 lag=0   e) PHASE 7 lag=1   f) PHASE 7 lag=2
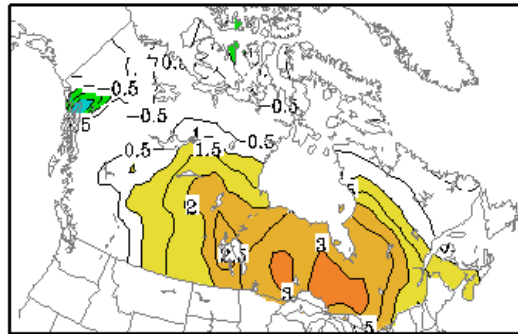
(Lin et al. JCLIM, 2009)

Impact on Canadian surface air temperature

Lagged winter SAT anomaly in Canada
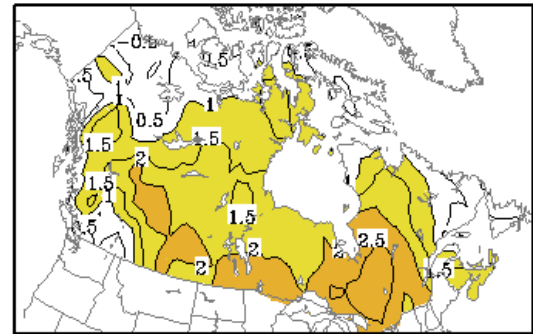

a) PHASE 3 lag=0   b) PHASE 3 lag=1   c) PHASE 3 lag=2

(Lin et al. MWR, 2009)
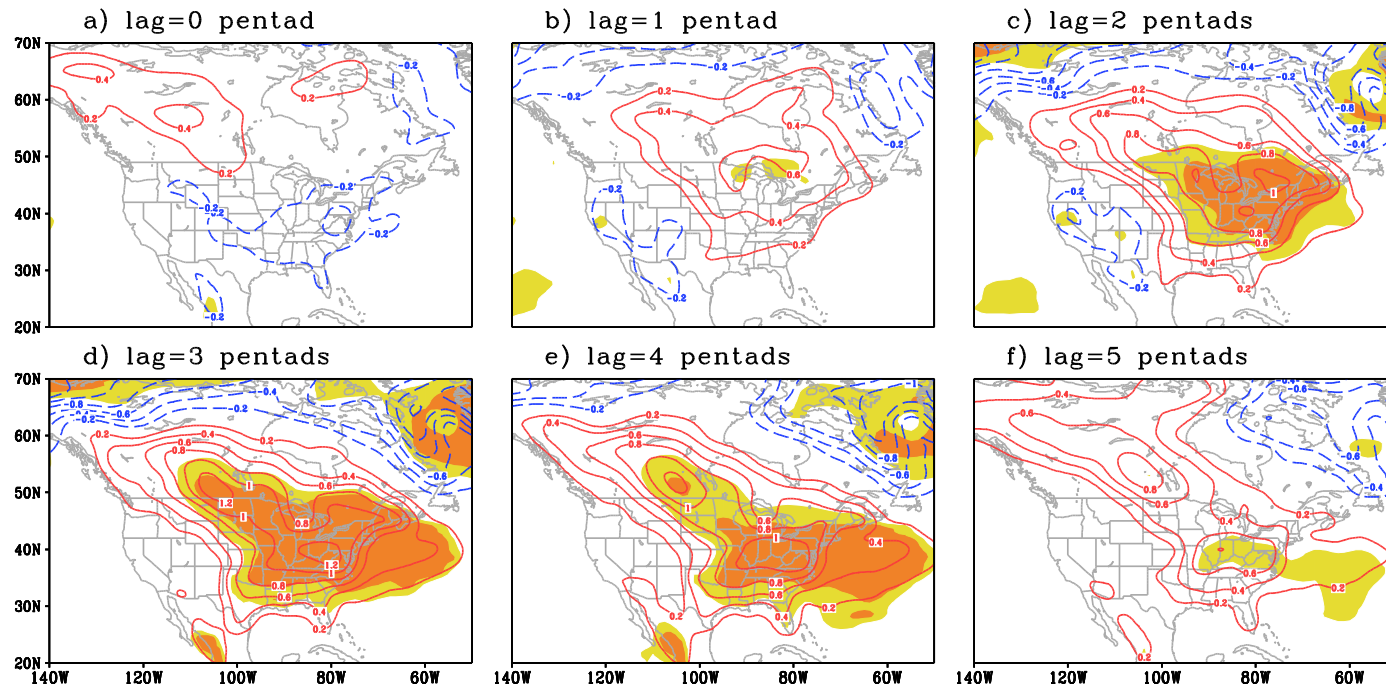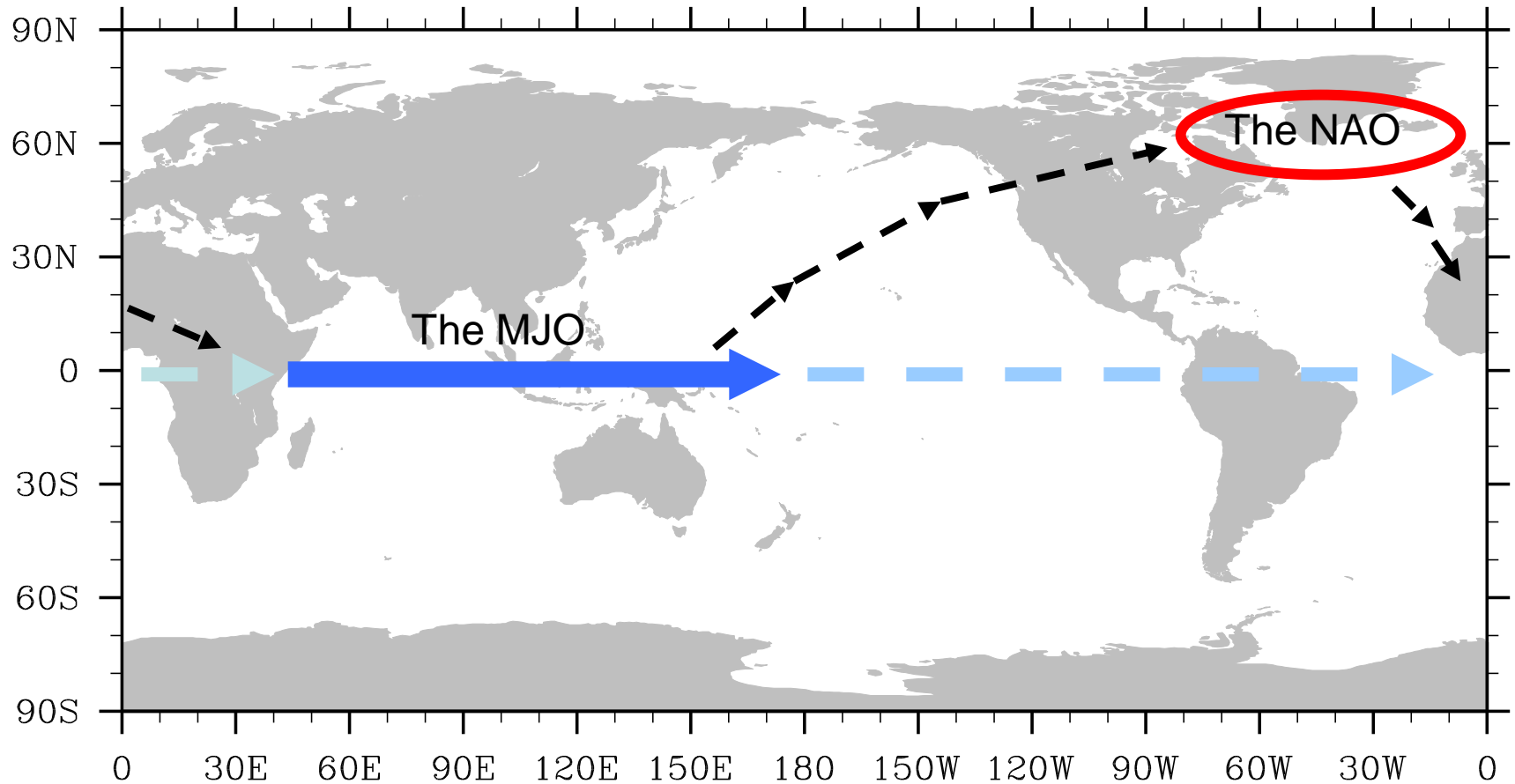
Impact on North American surface air temperature

Lagged regression of SAT with −RMM2

Two-way MJO – NAO interaction

ISO hindscast with GEM

- GEM clim of Canadian Meteorological Centre (CMC)--

    GEMCLIM 3.2.2, 50 vertical levels and 2° of horizontal resolution

- 1985-2008

- 3 times a month (1st, 11th and 21st)

- 10-member ensemble (balanced perturbation to NCEP reanalysis)

- NCEP SST, SMIP and CMC Sea ice, Snow cover: Dewey-Heim (Steve Lambert) and CMC

- 45-day integrations

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NAO forecast skill
extended winter – Nov – March
tropical influence

A simple measure of skill:
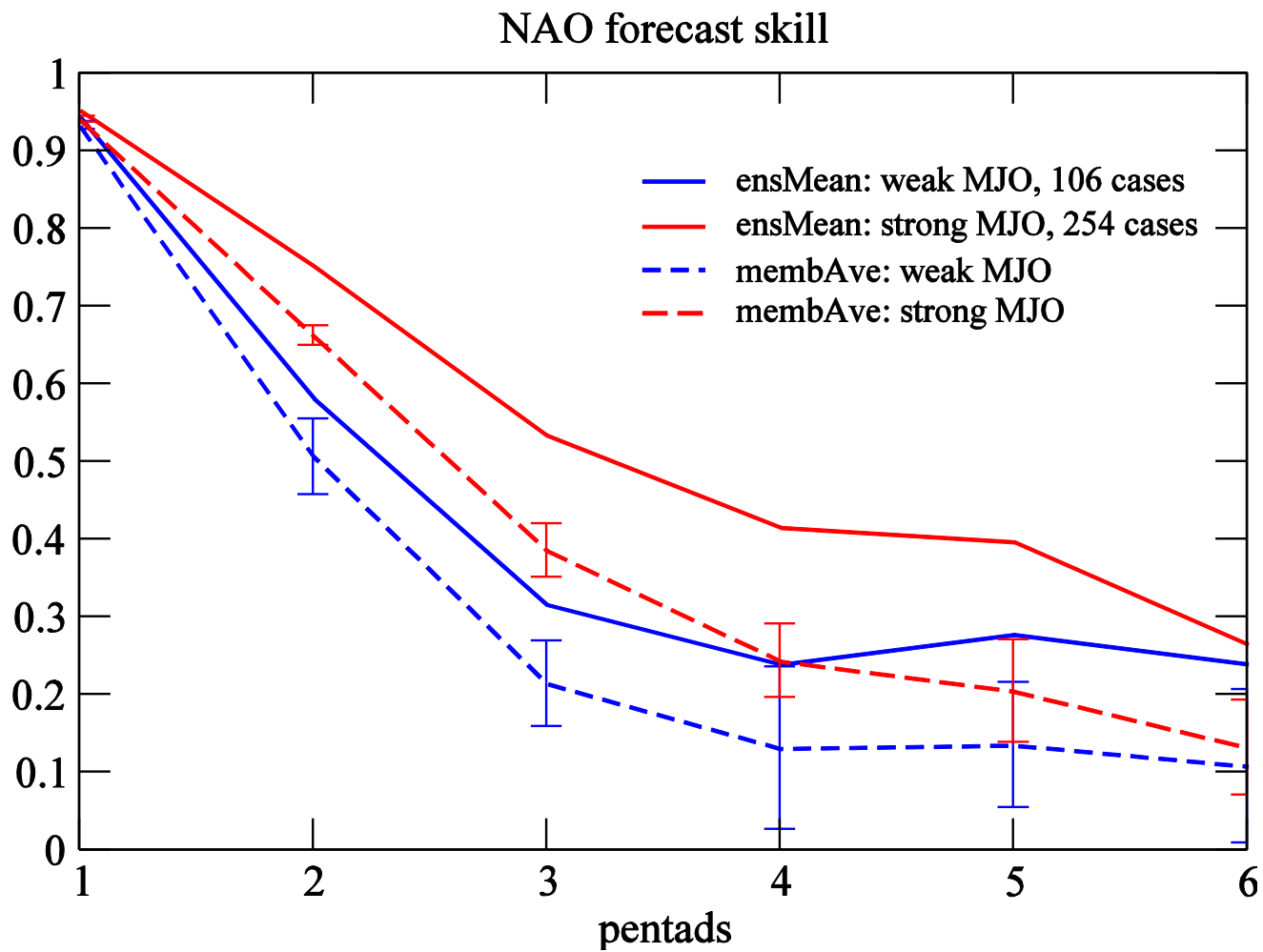
temporal correlation btw forecast and observations

NAO forecast skill

— GEM forecast
-- persistent

(Lin et al. GRL, 2010a)

NAO forecast skill

ensMean: weak MJO, 106 cases
ensMean: strong MJO, 254 cases
membAve: weak MJO
membAve: strong MJO

pentads

(Lin et al. GRL, 2010a)

NAO forecast skill

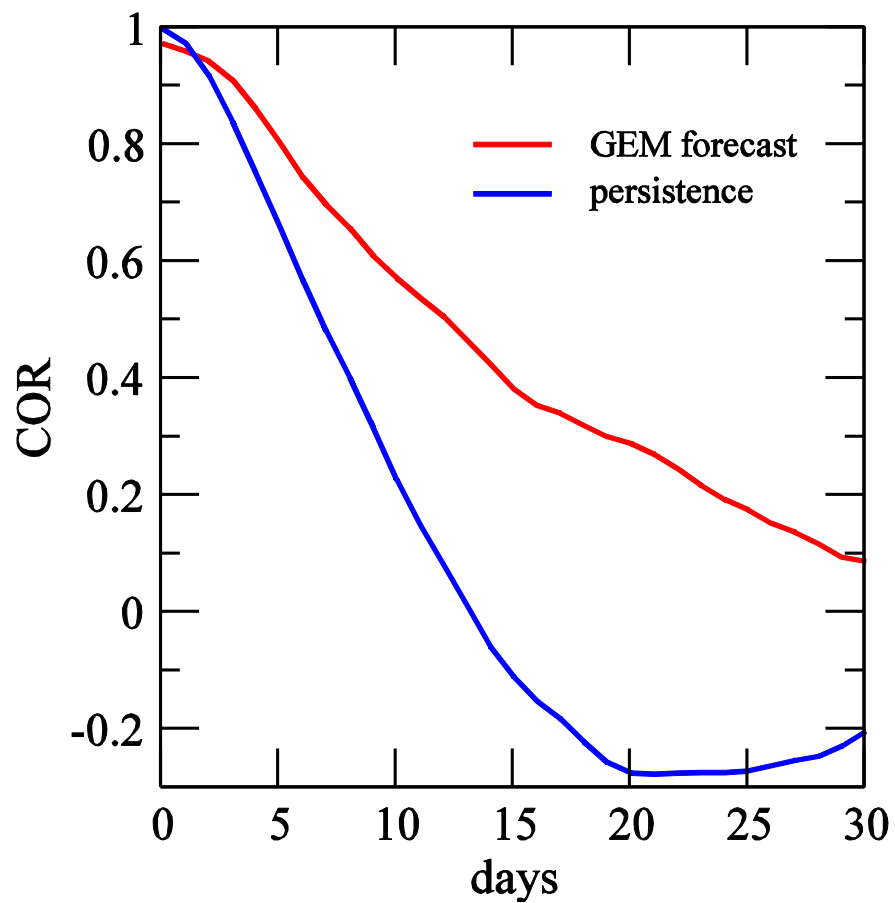phase8145, 119 cases
phase2367, 135 cases
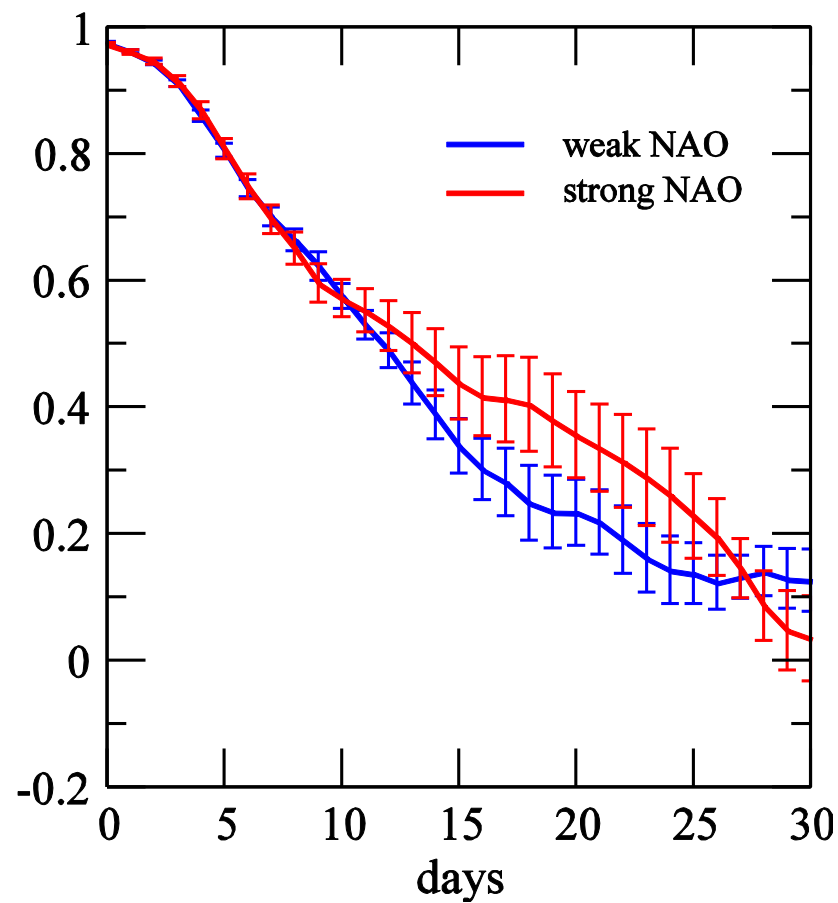
pentads
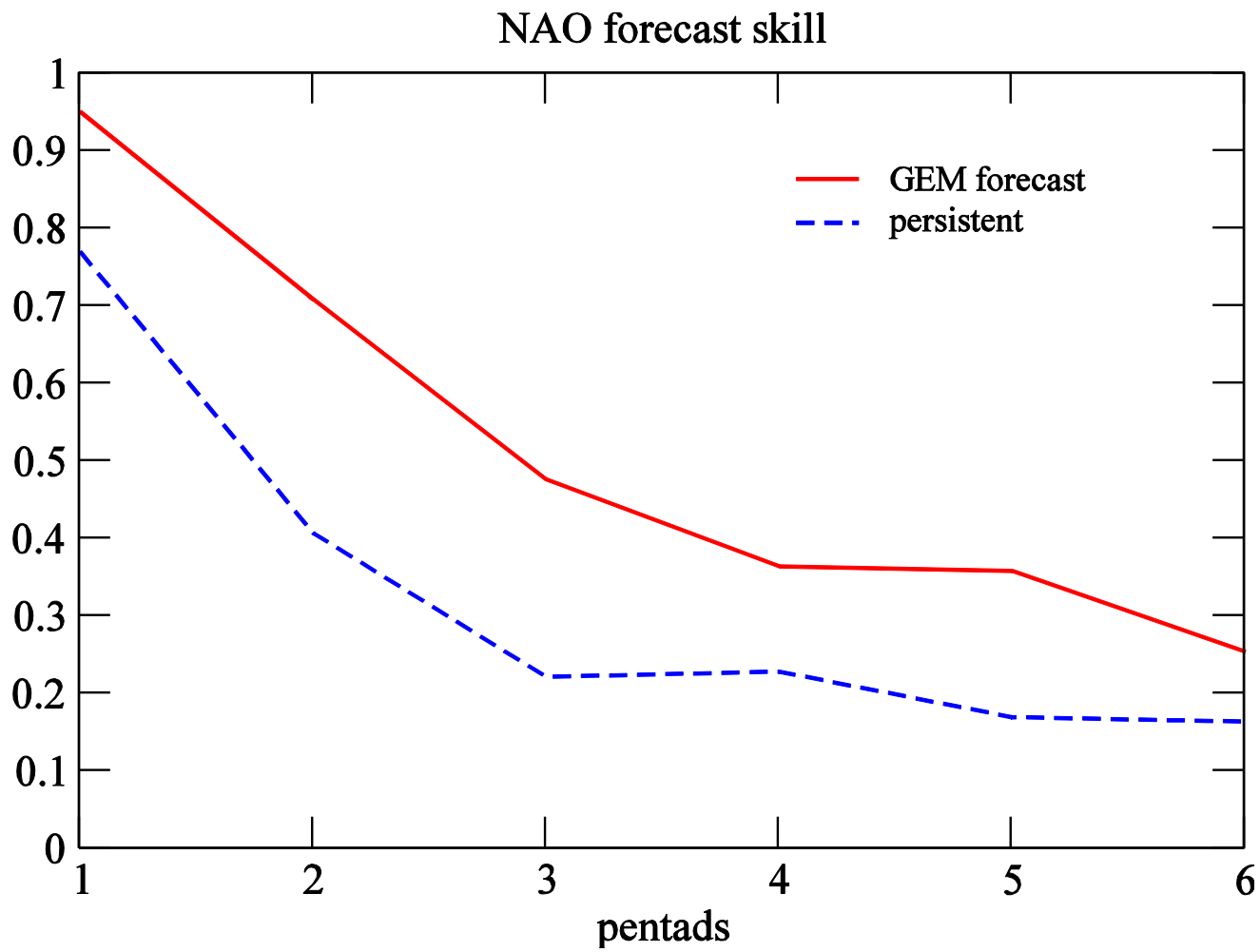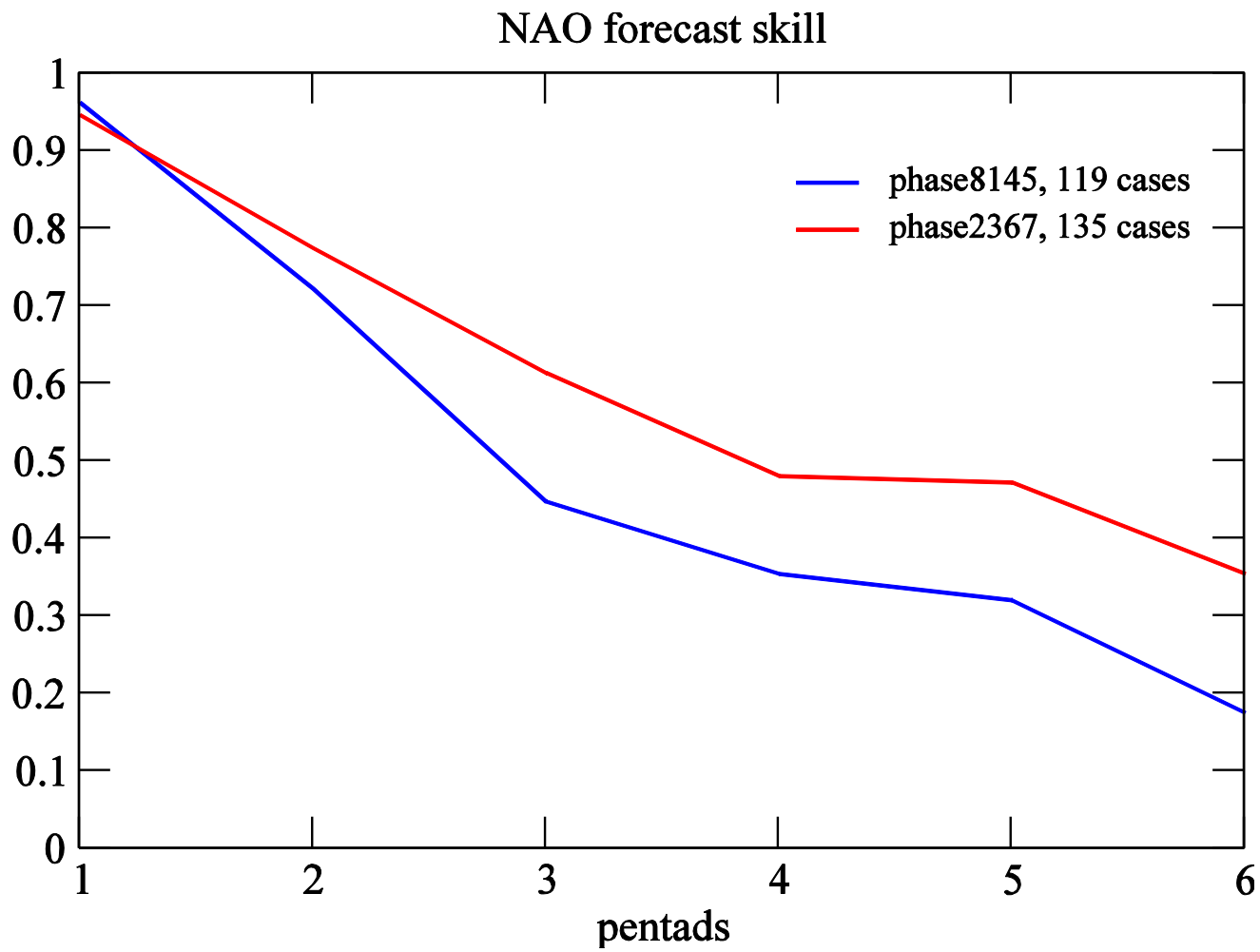
(Lin et al. GRL, 2010a)

MJO forecast skill
--- impact of the NAO

a) MJO forecast skill

b) MJO skill by initial NAO amplitude

(Lin et al. GRL, 2010b)

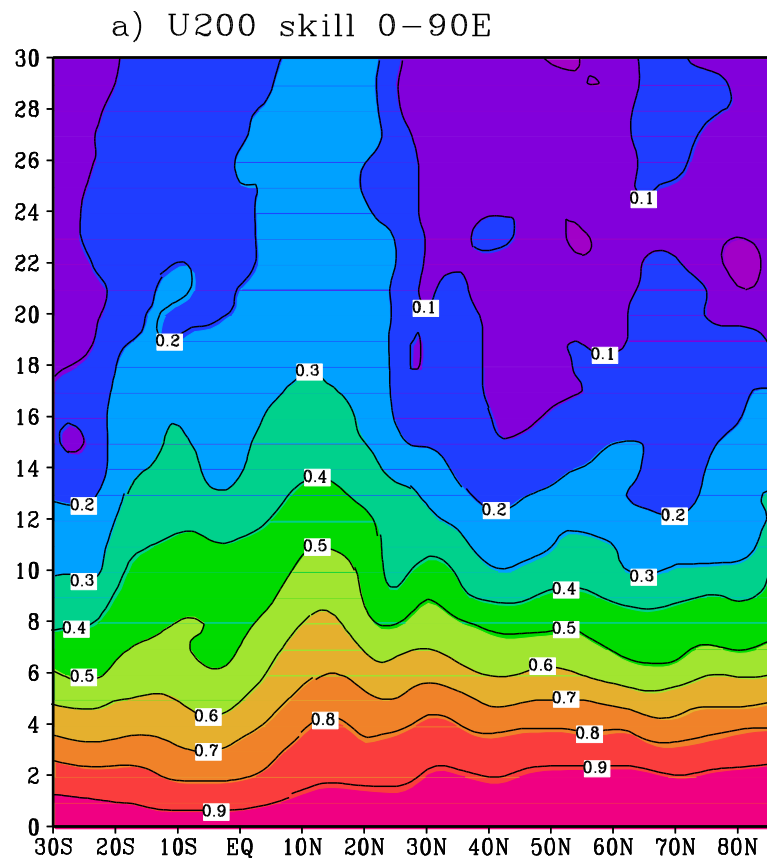a) U200 skill strong NAO

b) U200 skill weak NAO

c) U200 skill strong−weak NAO
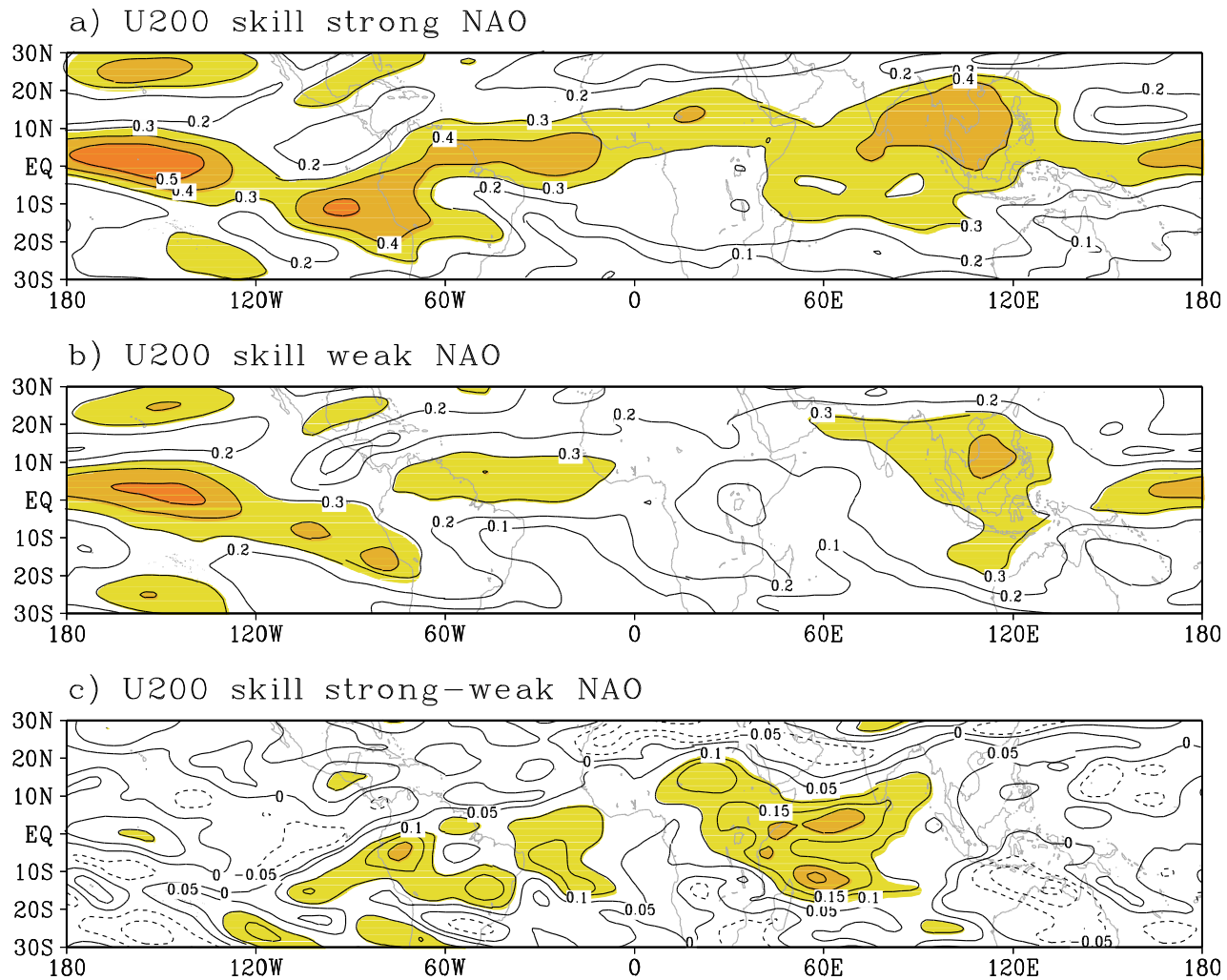
Skill averaged for days 15-25   (Lin et al. GRL, 2010b)

a) U200 skill 0-90E

b) U200 skill strong-weak NAO
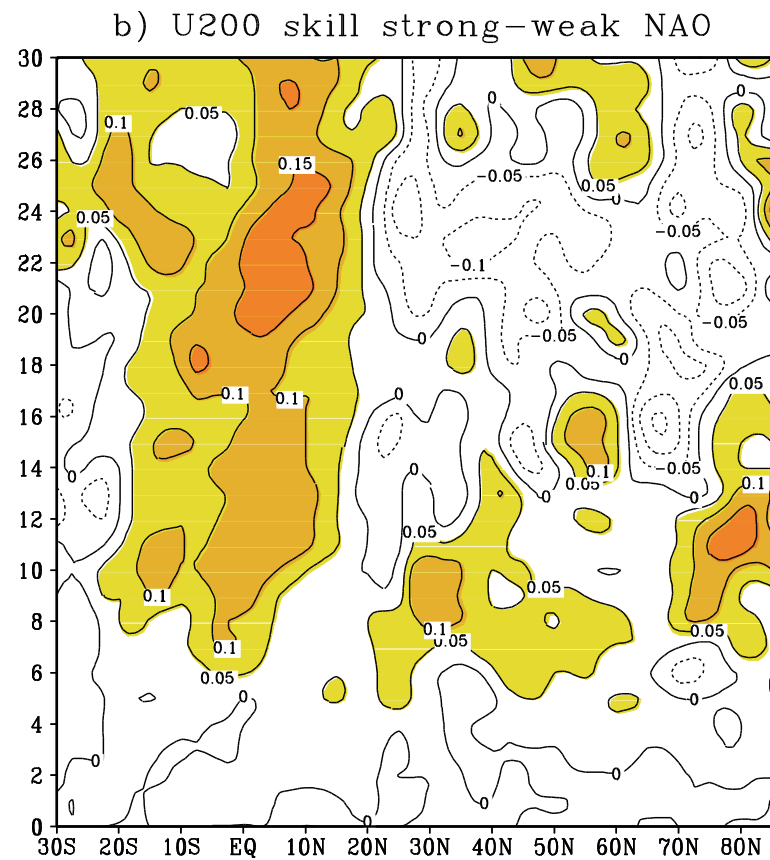
(Lin et al. GRL, 2010b)

Summary

- Two-way interactions between the MJO and NAO

- Lagged association of North American SAT with MJO

- NAO intraseasonal forecast skill influenced by the MJO
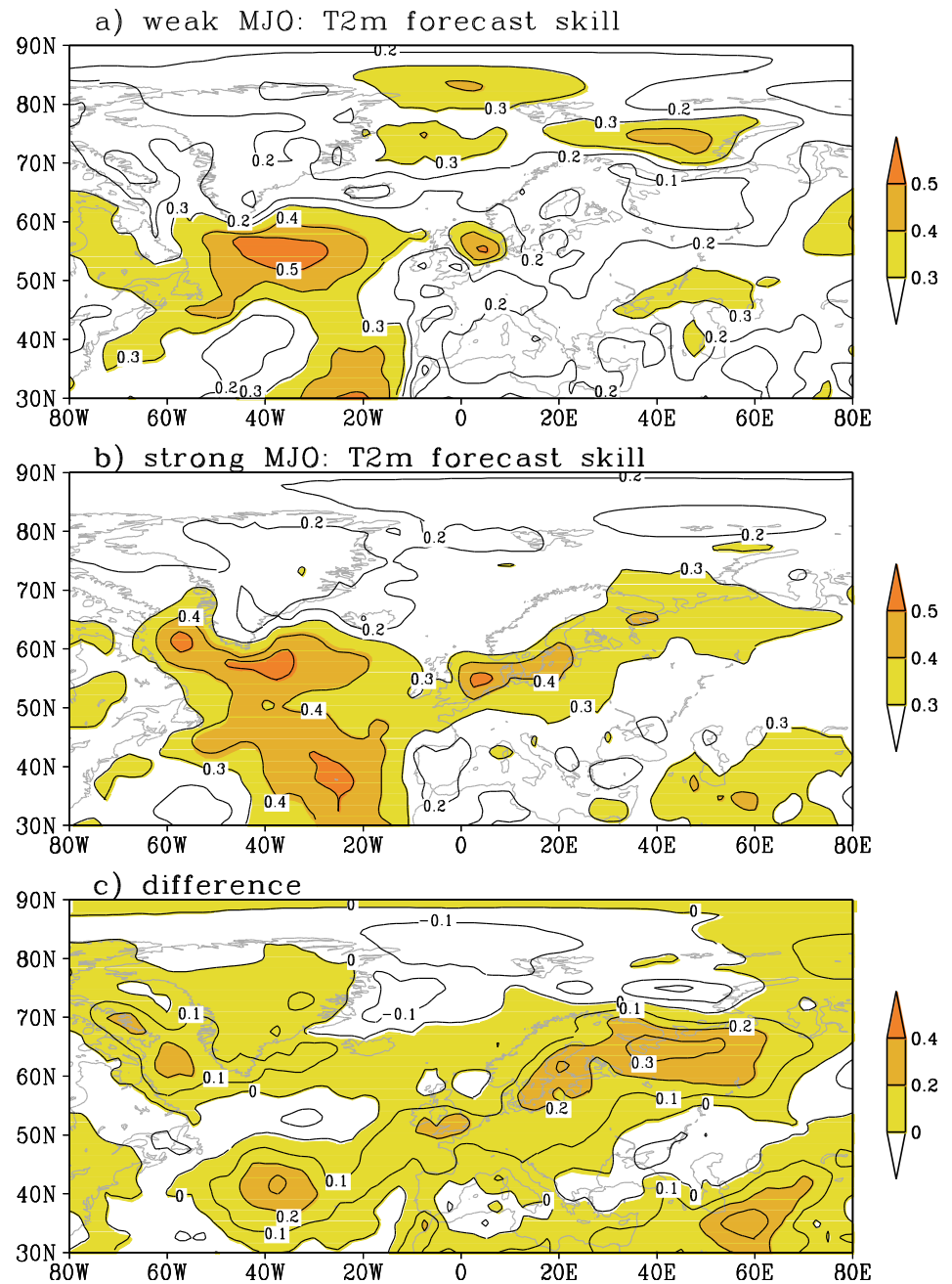
- MJO forecast skill influenced by the NAO

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Thank you!

Correlation skill: averaged for
pentads 3 and 4

a) weak MJO: T2m forecast skill

b) strong MJO: T2m forecast skill

c) difference

(Lin et al. GRL, 2010)